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A Critical Analysis of the Human Lens

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ABSTRACT

The eyes are one of the precious organs. The eyes are a very sensitive and vulnerable organ in the body as it is exposed to airborne infectious agents, pollutants, dust, and other particles, which can directly land on the surface of the eye. These may cause different eye diseases. A person who desires a long life must take care of his eyes throughout life, as for a blind man; there is no difference between day and night. Though he has wealth, he will remain poor. So Protection of eyesight is the top priority of Shalakya Tantra since the loss of vision completely disables a person.

KEYWORDS: *Eyes, Lense, humans, Ayurveda*

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INTRODUCTION

The human lens has all the attributes of a biconvex lens. It is the only organ that grows continuously in size throughout life. It provides 1/3rd of the dioptric power of the eye. The lens consists of anterior and posterior surfaces. It is enclosed by a capsule and is attached to the ciliary processes by the lens zonules. The centers of the anterior and posterior surfaces are called anterior and posterior poles respectively. The line joining the two poles is the axis of the lens. The circumference of the lens is called as the equator. The diameter is between 8.8 and 9.2 mm.

The thickness of the lens varies with accommodation. The unaccommodated thickness is about 4 mm at birth and does not increase much until adulthood. Thereafter there is a gradual linear increase in thickness. At birth, the lens weighs 65mg, at 20 years 152 mg, and 258 mg at 80 years. The radius of curvature of the anterior surface of the lens is 10 mm and of the posterior surface is 6 mm.

The capsule of the Lens

The capsule is a thick, transparent basement membrane consisting mainly of type IV collagen with a few Type I and Type III collagen. Laminin and fibronectin are also present. By electron microscopy, it is seen to consist of approximately 40 lamellae. The anterior capsule is formed by the lens epithelium and the posterior capsule by the elongation of the fiber cells. The anterior capsule thickens during life from 8 µm to 14 mm, while the posterior capsule remains at 2 to 3 mm thickness. It is thickest at the anterior pre-equatorial region and posterior pole. The anterior capsule is thicker peripherally than centrally. The capsule is permeable to small molecules and proteins up to 70 kDa. Unlike the lens, the most superficial part of the capsule is the oldest.

Lens Epithelium

Deep to the anterior capsule is a single layer of lens epithelial cells which are of 2 distinct types – cells of the central zone, which do not undergo mitosis, and cells of the germinative zone which give rise to lens fiber. The lens epithelium is polarised and as the lens is formed by an invagination of lens placode, the apical side faces inwards and the basal end outwards, next to the capsule. The cells of the central zone contain organelles and cytoskeleton proteins. There

are characteristic polygonal arrays or geodomes of microfilaments that line the apical end and attach to the lateral membrane and are thought to help maintain structure during accommodation. Unlike typical epithelial cells, there are no tight junctions or zona occludens between adjacent epithelial cells. These cells are interconnected by gap junctions and desmosomes. Through them, ions and metabolites of low molecular weight can be exchanged. Endocytosis allows nutrients and receptor-mediated substances across the epithelial fiber cell interface. Square arrays are present in the interface and are thought to be important in regulating volume. Amino acids are actively transported across the epithelium. Thus the lens epithelium modulates the passage of metabolites, nutrients, and electrolytes to the lens fibers. The anterior capsule is produced by these cells. These cells also contain receptors to insulin and β-adrenergic agonists are present.

Lens fibers

The lens fibers are produced by the mitosis of lens epithelial cells in the pre-equatorial zone, which elongates, turns through 180º, and undergoes differentiation with pyknocytosis and eventual loss of cell-organelles and the nucleus. This is one of the important factors in achieving transparency of the lens. The ends of these fibers flare as they meet the suture. This configuration ensures the tightest packing of fibers. The superficial lens fibers have 'ball and socket junctions' whereas the deeper fibers have grooves and ridges on their surface. As the lens fibers elongate and the new ones are formed the older ones are pushed towards the depth of the lens so that the young fiber lens is the most superficial. 90 percent of the mass of the lens fibers consists of a protein called crystalline (α-crystalline, β-crystalline, gamma crystalline).[1]

Lens Sutures

Suture is an area of discontinuity in the lens where the tips of the fibers meet. These tips are specialized regions with a concentration of organelles and enzymes. They may be the site of the exchange of nutrients, ions, essential metabolites, and receptor-mediated substances.

The embryonic nucleus formed by the primary lens fiber has no suture. The fetal nucleus has a pair of Y-shaped sutures: the anterior is upright and arms are at 120º to each other and the posterior is inverted. The fetal fiber tips all meet on one of six planes. In an adult, suture assumes the shape of a nine-pointed star.

Nucleus and Cortex

The substance of the lens has 2 distinct divisions – the cortex and the nucleus. The nucleus consists of all fibers laid down before birth. The embryonic nucleus of the primary lens fiber is surrounded by the fetal nucleus. Clinically the yellow-brown dense central zone viewed on a slit lamp is termed the nucleus, but in fact, it is the nucleus with an adjacent deep cortex. The nucleus consists of densely compacted lens fibers and has a higher refractive index than that of the cortex.

The cortex corresponds to the alternating zones of light and dark on slit illumination that corresponds to the areas of greater or lesser scattering of light. It is the peripheral part which contains the younger fibers.[2]

ANATOMY OF LENS – AYURVEDIC PERSPECTIVE

In the textbooks of *Ayurveda*, there is no special description of a structure called a Lens. *Susruta* has described *Pramana, Akara*, and *Lakshana* of *Drushti* in the chapter *Drushti roga vijnaneeyam adhyaya* of *Uttara Sthana. Drushti* is circular in shape and measures similar to the size of a *Masoora dala* (lentil seed). Externally it is covered by *Patalas* (layers) of an eye. It is composed of all 5 *Mahabhootas*, with a predominance of *Tejo-mahabhoota*. Despite this, it is *Sheeta Satmya* (accustomed to cold). Because of the predominance of *Tejo mahabhoota*, it shines like a *Khadyota* (light emitting fly) or *Visphulinga* (fire spark) when light is thrown on it.[3]

Considering these descriptions it can be inferred that this description of drushti refers to the morphology of a structure, which is visible and palpable. Hence, that particular description can be compared to the Anatomy of Lens.

DISCUSSION:

Lens is composed of 64% water, 35% protein, and 1% lipid, carbohydrate, and trace elements. The protein concentration in the lens is the highest among body tissues. The high protein content is required in the lens for the correct focus of light on the retina. The major proteins of the lens are crystallins which are extremely stable. The main types of protein are alpha (31%). Beta (55%) and gamma (2%) crystalline and insoluble albuminoids (12%).

The human lens is the only organ that grows continuously throughout life. Lens growth is achieved by cell division in the pre-equatorial anterior lenticular epithelium and their migration towards the equatorial region. Its sagittal thickness exhibits a greater percentage increase than its transverse diameter. Consequently, the curvature mainly of the anterior surface steepens, increasing the power of the lens. This may induce Curvature myopia in old age but usually does not happen, as it is compensated by the change in the gradient of the internal refraction index. Hence, humans do not become myopic.

Aging is a normal process in every living cell. It is the stage where Vata dosha is more predominant.[4] It results in *Jadata* of the structures like the lens and thus leads to loss of transparency. During this phase, there will decrease in the *indriya bala.* This occurs after the age of 70 years. According to Susruta, Madhya Vayas (16 to 70 years) is further divided into Vriddhi (16 to 20 years), Youvana (20 to 30 years), Sampoornata (30 to 40 years), and Hani (40 to 70 years). The last division ie, Hani is characterized by ishat parihani which refers to the initiation of degenerative changes.[5]

CONCLUSION:

In humans, the lens is the organ with the ability to change morphology and refractive power, designated as accommodation, to focus light from various distances and obtain clear retinal images. The accommodative ability of the lens depends on its structure and biological parameters. The lens grows throughout life, forming specific lens sutures and a unique gradient refractive index, and possesses regenerative ability under certain circumstances.

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